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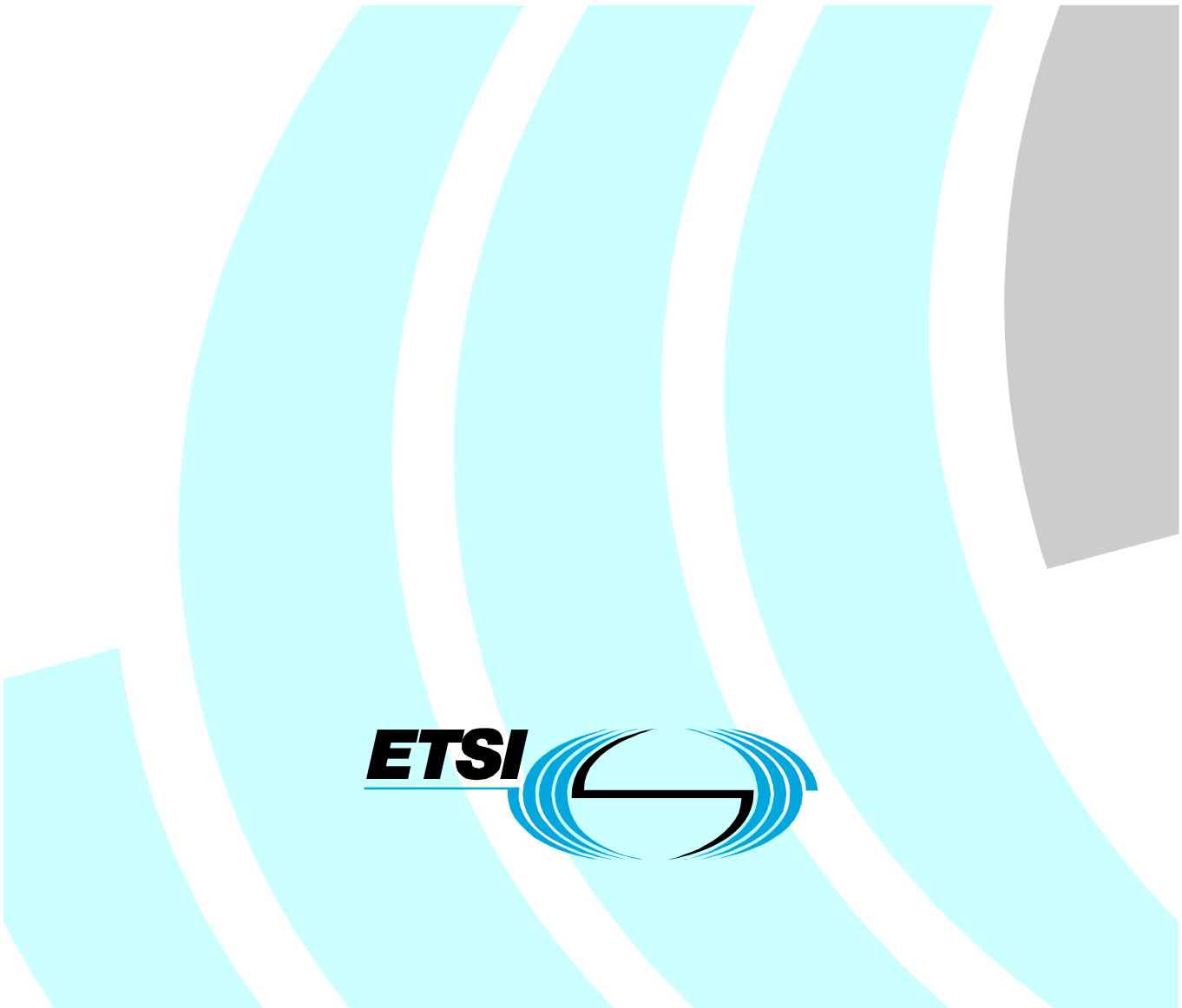
Technical Report

Electromagnetic compatibility and Radio spectrum Matters (ERM); Broadband Electronic Communications through Powerlines: A Code of Practice relating to the Standardization of the Measurement of Emission, Data Collection and Reporting of Results



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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document is designed to ensure a common approach to the measurement of emissions from PLC systems and to facilitate comparable and quantifiable information which Member States can report to the Communications Committee of the European Commission.

The European Commission Recommendation of 6 April 2005 on Broadband Electronic Communications through Powerlines states in clause 7:

7. Member States should report to the Communications Committee on a regular basis on the deployment and operations of powerline communications systems in their territory. Such reports should include any relevant data about disturbance levels (including measurement data, related injected signal levels and other data useful for the drafting of a harmonized European standard), interference problems and any enforcement measures related to powerline communications systems….

This Code of Practice deals with a number of issues relating to the deployment of PLC systems, but concentrates, in the main, on measurement methodology and reporting.

The principles proposed in this Code of Practice are designed to ensure an open and consistent measurement and reporting process, as required above, which should lead to the effective evaluation of the impact of PLC systems on radio communications services and other cable networks.

1 Scope

The present document is designed to ensure a common, open and consistent approach to the measurement and reporting process of emissions from publicly available broadband powerline communications systems and to facilitate comparable and quantifiable information which Member States can report to the Communications Committee of the European Commission following the European Commission Recommendation 2005/292/EC [3] on Broadband Electronic Communications through Powerlines in which it states in clause 7:

7. Member States should report to the Communications Committee on a regular basis on the deployment and operations of powerline communications systems in their territory. Such reports should include any relevant data about disturbance levels (including measurement data, related injected signal levels and other data useful for the drafting of a harmonized European standard), interference problems and any enforcement measures related to powerline communications systems….

The present document is intended to be used in its entirety.

The present document deals with a number of issues relating to the deployment of PLC systems, but concentrates, in the main, on measurement methodology and reporting.

The present document is applicable to trials and commercial deployment of PLC systems in the European Union and is expected to be used by regulatory authorities, operators of PLC systems and users of the radio spectrum.

The present document addresses, inter alia, three principal issues as required by the European Commission Recommendation 2005/292/EC [3]:

- Provision of details of any harmful interference caused by the operation of a PLC system.
- Emission measurement methodology and reporting in cases of interference.
- Mitigating measures and their effectiveness in such cases.

The present document calls for information on two levels in order to allow for a proper evaluation of the effect of PLC systems:

- The provision of generic information concerning the deployment of PLC systems in Member States.
- Specific information about particular PLC systems where harmful interference has been caused to radio services.

2 References

For the purposes of this Technical Report (TR) the following references apply:

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

[1] CENELEC EN 55014-1 (2000): "Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus - Part 1: Emission".

[2] CEPT/ECC/Recommendation (05)04: "Criteria for the assessment of radio interferences caused by radiated disturbances from wire-line telecommunication networks".

[3] Commission Recommendation 2005/292/EC of 6 April 2005 on broadband electronic communications through powerlines.

[4] CISPR 16-1-1: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus".

[5] CISPR 16-4-2: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 4-2: Uncertainties, statistics and limit modelling - Uncertainty in EMC measurements".

[6] ITU-R Recommendation P.372-8: "Radio noise".

[7] ITU-T Recommendation K.60: "Emission limits and test methods for telecommunication networks".

[8] CEPT ECC Report 24: "PLT, DSL cable communications (including cable TV) LANS and their effect on radio services".

3 Definitions

For the purposes of the present document, the following terms and definitions apply:

ambient noise: background noise entering a radio receiving installation at the measurement site

(electromagnetic) disturbance: any electromagnetic phenomenon which might degrade the performance of a device, equipment or system, or adversely affect living or inert matter

NOTE: Refer to IEC – IEV 161-01-05.

harmful interference: interference which endangers the functioning of a radio navigation service or of other safety services, or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Radio Regulations

NOTE: Source: ITU Radio Regulations.

measuring system: combination of measurement antenna, receiver and associated equipment, including cables

PLC system: system or part of a system that transmits and receives electromagnetic energy on frequencies above 9 kHz by conduction over medium and/or low voltage electric power lines, with the purpose of carrying information

4 Provision of Information

In order to assess the impact of PLC systems on other services information should be provided in a consistent format, to facilitate collation, comparison and evaluation.

This code specifies two types of information to be provided on PLC systems:

- Background information on the deployment of PLC systems.
- Specific information in cases of harmful interference.

4.1 Background Information

For each PLC network the measurement report should contain the following:

- System operator address and contact details.
- The name address and contact details of the electricity network owner involved.
- Physical nature of electricity network: overhead wiring / underground wiring / mixture.
- The location of the PLC system: rural / semi-rural / urban / industrial.
- The technical characteristics of the system - manufacturer, technology, frequency spectrum utilized and maximum injection signal levels.
- An indication of the number of households passed and the number of households subscribing.
- Date of activation.

In order to help identify and resolve cases of harmful interference, National Administrations are encouraged to adopt an open approach to publicizing the above information on PLC systems operating within their territory.

4.2 Specific Information in cases of harmful interference from a PLC system

In cases of harmful interference, data should be reported indicating the nature of the interference and the technical and operational characteristics of the PLC system concerned.

An assessment of radio interference should be carried out where preliminary mitigation measures have been ineffective:

- following the guidance given in the ECC Recommendation (05)04 [2];
- using an alternative method provided this is documented in the test report.

It may be necessary for PLC operators to change operational conditions, which may include selective closedown of a system (including repeaters) for short periods to aid identification of the source of interference.

Where remedial action has been taken this should be reported and described in detail if possible.

It is recommended that a general common reporting format (see annex A) be developed to aid collation and analysis of the results of cases of interference across Europe.

In addition to the information required in clause 4.1 the following information should be provided in cases of harmful interference:

- Network status at time of interference, the operating mode of the network such as active, passive or test or other mode.
- Number of interference cases reported in the specific location and type of premises (house, flat, high-rise, housing density etc.).
- Identification of the service experiencing interference and frequencies affected.
- Where applicable relevant details of equipment affected parameters e.g. antenna characteristics.
- An electrical network plan, where this has been used in measurements.
- Distance from PLC network cabling and the levels of both the wanted signals and the disturbance at the equipment affected Description of what mitigation measures have been applied and whether these have been successful.

The investigation report may also contain the following where appropriate:

- name of organization making the measurement;
- location of the measurements and description of the location including whether indoor or outdoor;
- description of the installation subject to interference;
- time and date of the measurement;
- details of the measuring equipment;
- set-up of the measuring equipment including any deviations from standard practice;
- ambient noise at the measurement site;
- measuring system noise floor;
- field strength of the wanted signal;
- field strengths of disturbance at victim location;

- method used to extrapolate to the reference distance in case measurements are not made at reference distance;
- photographs or drawing of the measurement location.

5 Emission measurement methodology

This clause specifies measurement procedures and guidelines for the documentation of measurements.

Where applicable, the methods should rely on already published documents either in CISPR, ETSI or CENELEC.

5.1 General Arrangements

In order to assess the disturbances, the PLC system should operate under normal operating conditions during the measurements.

An initial measurement survey should be carried out to determine the variation of the disturbance levels at the location.

The measurement antenna should be located as close as practical to the reported location of the equipment affected. An initial sweep over a range of representative frequencies should be made, including the operational frequencies of the equipment being affected, in order to identify the interference mechanism and disturbance frequencies.

Where outdoor measurements are made an electricity distribution network plan should be used.

The measurement report should state any deviation from standardized measurement procedure.

5.2 Swept Frequency Emission Measurements

The following clauses define the recommended process.

Program the receiver to scan between two frequencies that lie either side of the known PLC spectrum blocks. Set the receiver to scan in steps of half the required measurement bandwidth as defined in CISPR 16-1-1 [4]. Set the measuring time for each frequency step to the shortest interval that suits both the nature of the PLC signal and the type of detector being employed so that the magnitude of any interfering signal can be recorded.

A useful procedure is to pre-determine the receiver's detector response to the PLC signal by sampling the signal in a high signal to noise ratio measurement. This can best be achieved using a conducted PLC signal when comparisons between the amplitude response of the Peak and other detectors can be readily established. Once these are known, it will be quicker to carry out all the PLC disturbance emission measurements using a peak or average detector and if necessary, retrospectively convert the results for other detector types using a spreadsheet programme.

This method, in conjunction with a spreadsheet program, gives a complete picture of the entire PLC spectrum at each measuring position. Reliance on limited data from a few spot frequency measurements is avoided and the overall levels and trends can be reliably and quickly established. For example, data from different measuring positions, antenna polarizations and PLC network configurations can be readily combined in the same chart.

The benefits of this approach to measurement are easier measurement and presentation of:

- Relative levels of ambient noise and PLC disturbance emissions.
- PLC signal regression characteristics.
- The effect of PLC spectrum notching.

5.3 Radiated measurements below 30 MHz

A calibrated measuring system in accordance with CISPR 16-1-1 [4] consisting of a radio disturbance measuring receiver, an associated loop antenna with tripod for the measurement of magnetic field components may be used. Other specialized antennas ,e.g. resonant loop antennas or electrical antennas may also be used. The measuring system noise floor should be at least 6 dB below any emission level being measured.

In the frequency range 1,6 MHz to 30 MHz, a measuring bandwidth of 9 kHz and a Quasi-peak and Average detector should be used. It is recommended that both the measuring receiver and the loop antenna have an independent power source with no ground connection (e.g. battery power), particularly in case of indoor measurements, in order to minimize the possibility of current loops via earth that could affect the measurement.

5.4 Radiated measurements above 30 MHz

The electric component of radiated disturbance emissions should be measured as electric field strength.

For disturbance emission measurements in the frequency range above 30 MHz a calibrated measuring system in accordance with CISPR 16-1-1 [4], consisting of a radio disturbance measuring receiver (or a suitable spectrum analyser) in conjunction with an associated broadband dipole or a logarithmic-periodical antenna and mast, or similar linearly polarized antenna, each suitable for measurement of electric components of the electromagnetic field should be used In the frequency range above 30 MHz, a measuring bandwidth of 120 kHz and a quasi-peak detector should be used. If the noise level; of the measuring receiver or spectrum analyser is too great, then the radiation may be identified by using a much narrower bandwidth and the result scaled to the specified bandwidth assuming constant power per unit bandwidth (constant dBm/Hz). By this means, a noise floor at least 10 dB below the limit level may be achieved.

At the specified measurement location and measuring point(s), the direction, height, and polarization (horizontal and vertical) of the measuring antenna should be varied in order to determine the maximum RF disturbance field strength. The electrical component of the disturbance field strength should be determined by observing the indication of the measuring receiver over a period of approximately 15 s and subsequent recording of its maximum indication. Any short duration isolated peaks should be treated as in clause 5.6 on Short Term Peaks.

If due to local restrictions the measuring antenna cannot be placed at the location of the equipment being investigated, then measurements may be used to determine the profile of the source of disturbance.

5.5 Emission measurements in the presence of wanted radio signals

The measurement of magnetic or electric fields radiated from PLC networks in the frequency range up to 30 MHz or above 30 MHz may be complicated due to the presence of a variety of high-level wanted RF emissions from radio services.

In certain circumstances it may be difficult to identify PLC emissions because of the presence of wanted radio signals. In such cases it may be necessary to change the operational conditions of the PLC network in order to verify the source of disturbance.

If the operational mode of the PLC network cannot be altered, then the following alternative may be used for both swept and single frequency measurements:

- orientate the loop antenna for minimum coupling to the suspected network and make a measurement;
- orientate the loop antenna for maximum coupling to the suspected network and make a measurement;
- check that the measurement result with maximum coupling is at least 6 dB higher than for minimum coupling. If it is not, consider decreasing the measurement distance to increase the PLC emission to wanted radio signal ratio;
- to verify that the PLC disturbance emission measured with maximum coupling is being generated by the nearest part of the PLC network, increase the measurement distance and again set the measuring antenna for maximum coupling. Make a new measurement and check the decrease in field strength.

In general the methods described above cannot be used for in-house measurements where the measuring antenna is surrounded by PLC network cables.

5.6 Short Term Peaks

Short term peaks are treated in accordance with EN 55014-1 [1], clause 4.2.3.3 and when measured with a quasi-peak detector, are ignored provided it is indicated that they meet the following requirements:

- they occur at a rate of less then 5 per minute;
- none are longer than 20 ms; and
- 90 % are shorter than 10 ms.

6 Processing of obtained measurement results

6.1 Correction of measurement results due to near field conditions

Measurement results for the magnetic or electric disturbance field strength obtained by use of the measuring system and reference distance according to clause 5.3 do not need any related subsequent correction, even if the reference distance implies "near-field" conditions.

6.2 Treatment of measurement uncertainty

The estimate of the measurement instrumentation uncertainty is calculated according to CISPR 16-4-2 [5] and both the measurement results and the calculated uncertainty should be recorded in the test report.

7 Mitigation Measures

In cases of harmful interference, administrations and PLC system operators will want to consider mitigation measures to reduce the effects of harmful interference. These measures should be deployed and evaluated such that their effectiveness can be measured and reported.

In reporting actions taken in cases of harmful interference, administrations should include details of the mitigation measures attempted and their effectiveness.

Administrations should include in any reporting form enforcement measures taken in the case of harmful interference to radio services. PLC operators are recommended to work with authorized users of the radio spectrum who are experiencing interference from PLC operations, to understand the effectiveness of various mitigating actions taken.

Annex A:
Reporting Pro Forma

To be used in conjunction with ETSI TR 102 552: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Broadband Electronic Communications through Powerlines: A code of Practice relating to the Standardization of the Measurement of Emission, Data Collection and Reporting of Results".

Part A: To be completed by all Administrations

Country:
Administration:
Contact person:
e-mail:
Postal Address:

Telephone:
Date of return:

Are there PLC systems operating in your country (Yes / No)
(If "No", the form is complete. Otherwise go to Part B)

Part B: To be completed for each operating PLT system

Electricity distribution network owner:

Contact person:

Telecommunications system operator name:

Contact person:

Physical nature of network wiring (put "X" against one):
Overhead . Underground . Mixture

Network topography (put "X" against one or more):
TNC TNS TNC.S IT TT

Location of PLC system (nearest town/post code):

Classification of location of PLC system (put "X" against one or more):

Rural Semi-rural Urban Industrial

Number of premises passed

Number of subscribers

How many cases of interference have been reported to any radio service ?

Have technical investigations taken place about these reports ? (Yes / No)

If "Yes" go to part C. Otherwise, the form is complete

Part C: Technical investigations carried out in cases of interference to radio services

(1) Generic Information on PLC System

Technical characteristics of PLC system:

Manufacturer

Technology employed

Modem make and model

Frequency spectrum occupied

Maximum injection signal levels

Date PLC system activated

Is a notching facility available ? (Yes/No)

Radio services reporting interference and numbers of cases:

Safety of life

Private mobile radio

Broadcast

Government

Amateur Radio

Radio Astronomy

Other

(2) Measurements Carried Out

Organization responsible for measurement:

Name of organization:

Name of contact person:

e-mail address

Postal address

Telephone

Network status at time of measurement (put "X" against one):

Active Passive Test Other

Type of premises reporting interference (put "X" against one):

House Apartment High-rise Industrial/Commercial
Other

Radio service and frequencies experiencing interference:

Equipment affected (receiver and antenna)

If swept frequency measurement used:

Level of PLC disturbance emissions relative to ambient noise or measuring system noise floor (state which) + dB

PLC regression characteristics

Effect of PLC spectrum notching (if applicable) dB improvement

Radiated measurements:

Ambient electrical noise at site in the absence of intentionally radiated signals dBuV/m

Measuring system noise floor dBuV/m

Field strength of wanted signal near victim antenna dBuV/m

Field strength of PLC disturbance at same place dBuV/m

Distance of PLC cabling from victim antenna m

PLEASE ATTACH ANY PLOTS OF INTERFERENCE LEVELS BY FREQUENCY

Part C (2) continued

Location of measurements (include a plan)

Time / date of measurement

Measuring equipment type

Antenna used

Describe the set-up of measuring equipment, highlighting any deviations from standard measurement practice

Part D: Mitigation

Were actions taken to try to mitigate the effects of interference ? Yes/No

If "No", the form is complete

If "Yes", describe mitigation steps taken

Describe the effect of these on the interference at the victim receiver

What level of reduction in interference was achieved ?

History

Document history		
V1.1.1	July 2007	Publication